WELCOME TO
NASA APPLIED REMOTE SENSING TRAINING (ARSET)
WEBINAR SERIES

INTRODUCTION TO REMOTE SENSING FOR WILDFIRE APPLICATIONS

COURSE DATES: EVERY TUESDAY, MARCH 31- APRIL 28
TIME: 11:30 AM-12:30 PM EST

Important Information

- One lecture per week – every Tuesday from March 31 to April 28 (11:30 AM – 12:30 PM EST)
- Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at: http://arset.gsfc.nasa.gov/disasters/webinars/introduction-remote-sensing-wildfire-applications
- Certificate of Completion
  - Attend 4 out of 5 webinars
  - Assignment 1 and 2 – access from the ARSET wildfire webinar website (above)
  - You will receive certificates approximately 1 month after the completion of the course from: marines.martins@ssaihq.com
- Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

ARSET Wildfire Management

http://arset.gsfc.nasa.gov/eco/webinars/land-management

Registration: **https://arset.adobeconnect.com/wildfire/event/registration.html**
Agenda: **NASA_ARSET_Wildfire_Webinar_Agenda.pdf**
Keywords: **Ecosystems, Fires and Smoke, Satellite Imagery, Vegetation Indices**
Instruments/Missions: **Landsat, MODIS, NPP, SMAP, VIIRS**

Presentations and Recordings

Week	Date	Title	Presentation	Recording	Assignment
1	March 31, 2015	Overview of remote sensing	**Week 1 Presentation** **Week 1 Presentation (Spanish)**	View Week 1 Recording	N/A
2	April 7, 2015	Satellite sensors and data products for wildfire applications	Week 2 Presentation Week 2 Presentation (Spanish)	View Week 2 Recording	**Assignment 1**
3	April 14, 2015	Remote sensing products for pre- and post-fire wildfire planning and assessment	Week 3 Presentation Week 3 Presentation (Spanish)	View Week 3 Recording	N/A

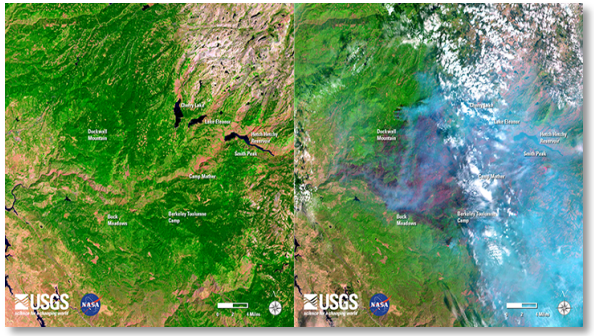
Your Course Instructors

- Cindy Schmidt (ARSET): cynthia.l.schmidt@nasa.gov
- Amber Kuss (ARSET): amberjean.m.kuss@nasa.gov
- Guest Speakers:
  - Tony Guay – USDA Forest Service Remote Sensing Applications Center (week 3)
  - Keith Weber – Idaho State University (week 3)
  - Dale Hamilton – Northwest Nazarene University (week 4)
  - Mark Carroll – NASA Goddard (week 4)
  - Lindsey Harriman and Kelly Lemig – LP DAAC (week 5) lharriman@usgs.gov, klemig@usgs.gov

General inquiries about ARSET: Ana Prados (ARSET) aprados@umbc.edu

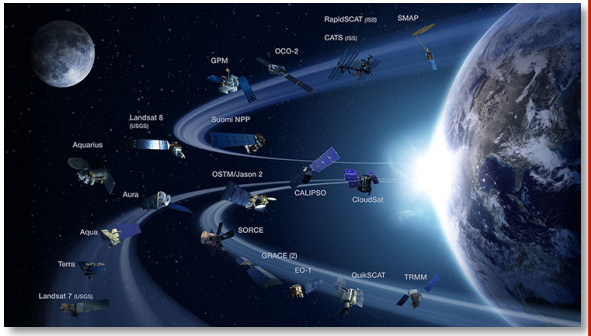
Course Outline

Week 1



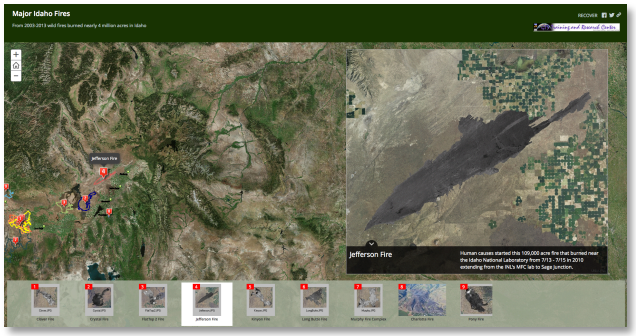
Overview of satellite remote sensing

Week 2



Platforms and sensors for wildfire applications

Week 3

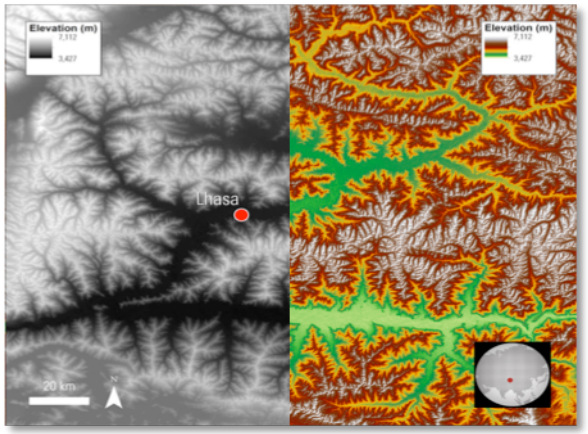


Products and tools for pre and post-wildfire

Week 4

New techniques and technologies

Week 5



Terrain data applications

Week 2 Agenda

- Brief review of last week
- Satellite data processing levels
- Overview of satellite sensors for wildfire applications
- Satellite products and tools for data access
- Live Demos:
  - FIRMS MODIS active fires
  - Worldview

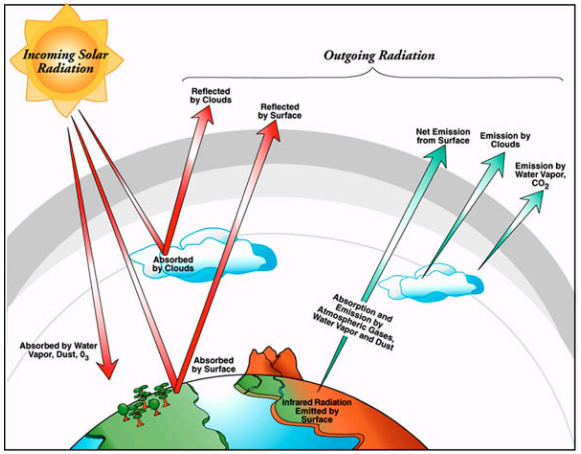
Review of Week 1

Wildfires: Global Critical Issues

- Loss of human life and property
- Air pollution
- Habitat loss
- Hydrological regime changes and increased risk of landslides
- Increased frequency, duration, and severity due to fire suppression methods and climate change

Fundamentals of Remote Sensing

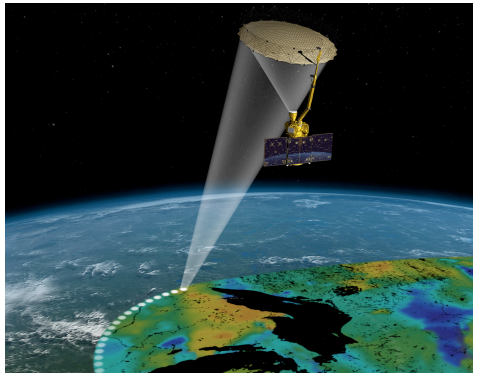
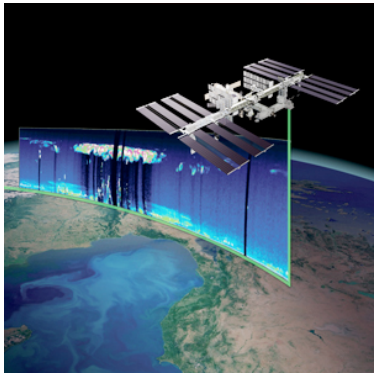
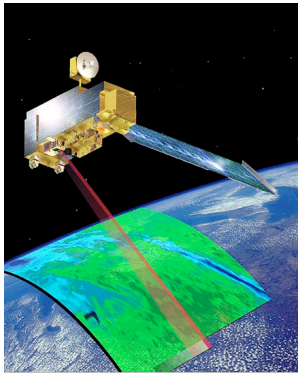
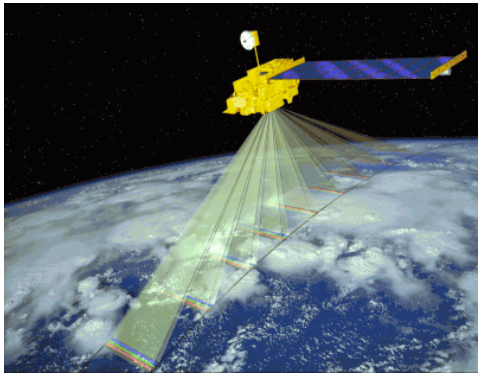
- Remote Sensing
  - Electromagnetic spectrum
  - Spectral signatures
  - Advantages/ Disadvantages
- Characteristics of satellite sensors
  - Passive vs. active
- NASA satellites for wildfire applications



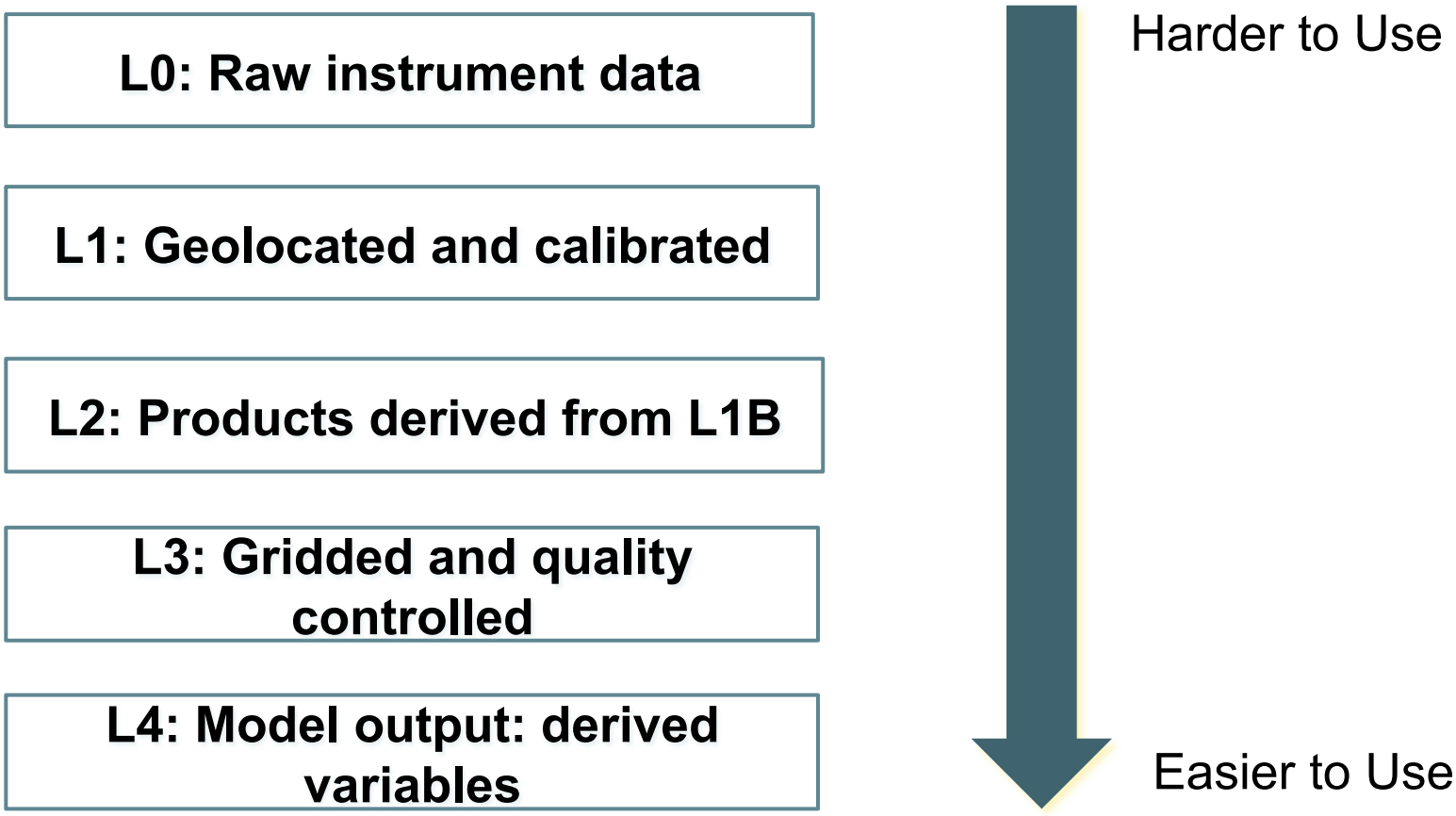
Satellite Data Processing Levels

Levels of Data Processing and Spatial Resolution

- **Level 1 and Level 2** data products have the highest spatial and temporal resolution.
- **Level 3 and 4 products** are derived products with equal or lower spatial and temporal resolution than Level 2 products.

Data Processing Levels



Data Processing Levels

Landsat	MODIS
Level 1T – Standard Terrain Corrected	**Level 2** – derived geophysical variables
Level 1Gt – Systematic Terrain Correction	**Level 2G** – level 2 data mapped on a uniform space-time grid scale
Level 1G – Systematic Correction	**Level 3** – gridded variables in derived spatial and/or temporal resolutions
	Level 4 – model output or results from analyses of lower level data

Landsat: Use level 1 imagery that includes spectral characteristics
MODIS: Use level 2, 3, or 4 products

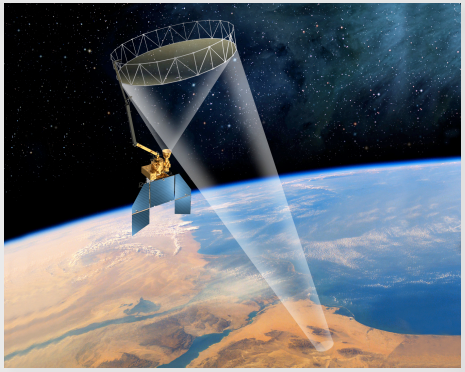
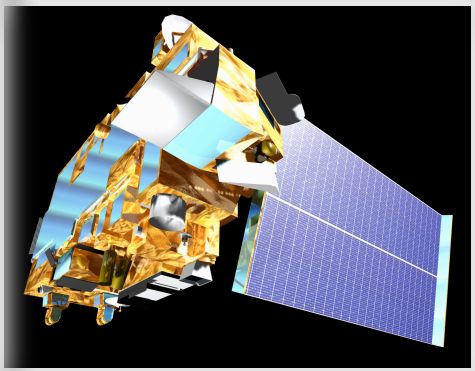
For more information on Landsat data processing levels:
http://landsat.usgs.gov/Landsat_Processing_details.php

For more information on MODIS Land Products processing levels:
http://lpdaac.usgs.gov/products/modis_products_table/modis_overview

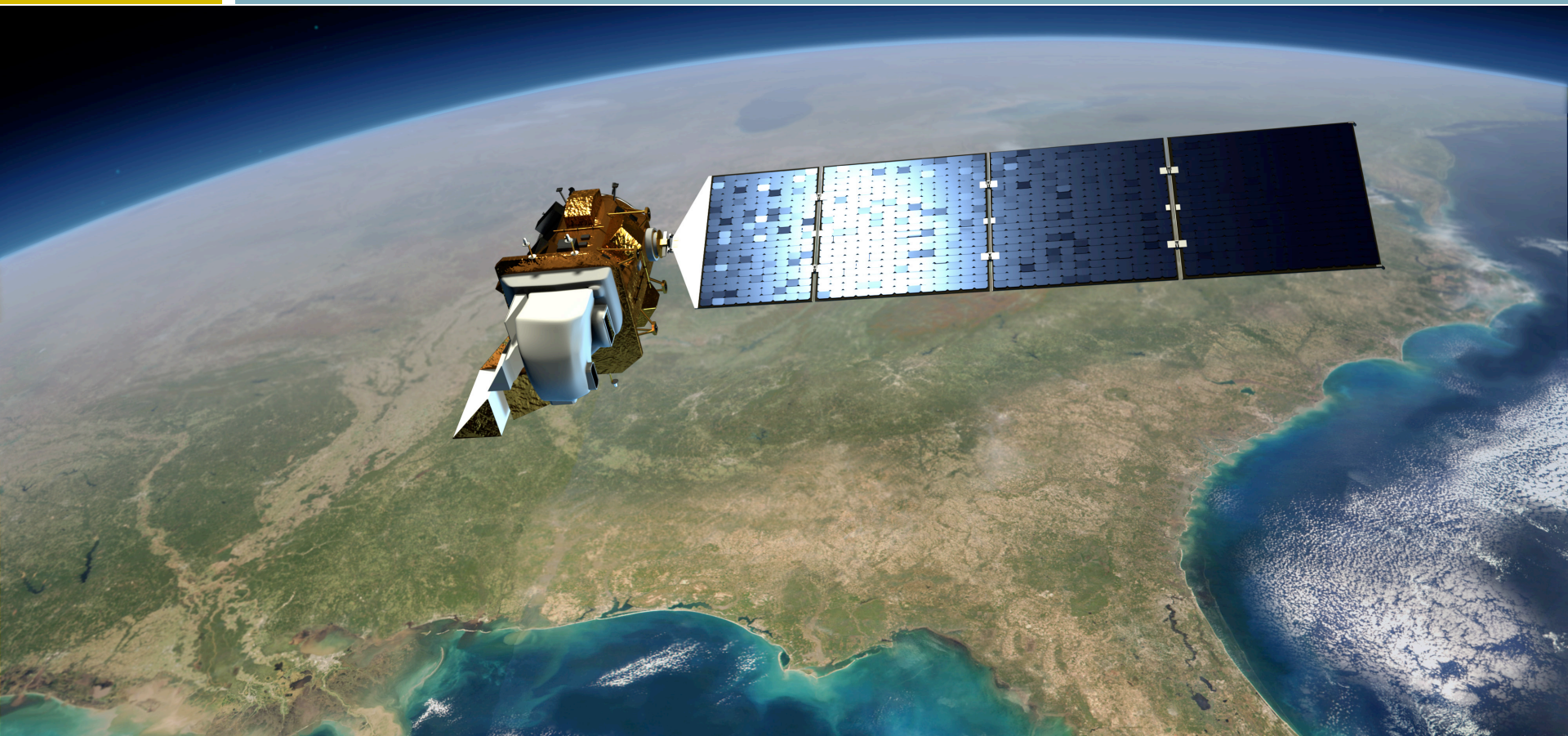
Wildfire Satellites and Sensors

- Brief Overview (History and Current Missions)
- Characteristics of the Data
- Where to Obtain Images
  - **Landsat**
  - **MODIS**
  - **SMAP**

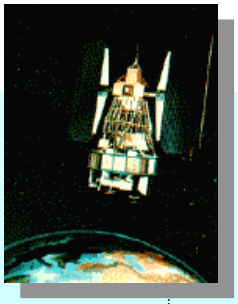


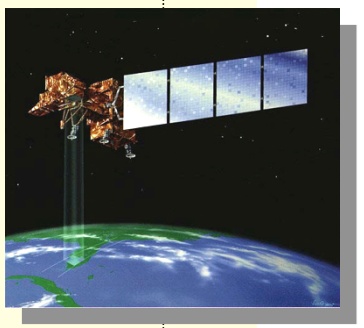



Landsat



Landsat: 30 Years of Observations





Landsat-1 (ERTS)

Landsat-2

Landsat-3

Landsat-4

Landsat-5

Landsat-6

Landsat-7

MSS (79 m, 4 band)

TM (30/120 m, 7 band)

ETM+ (15/30/60 m, 8 band)

Landsat 8 (15/30/90 m, 9 band)

Landsat 8
Launched 11 Feb. 2013

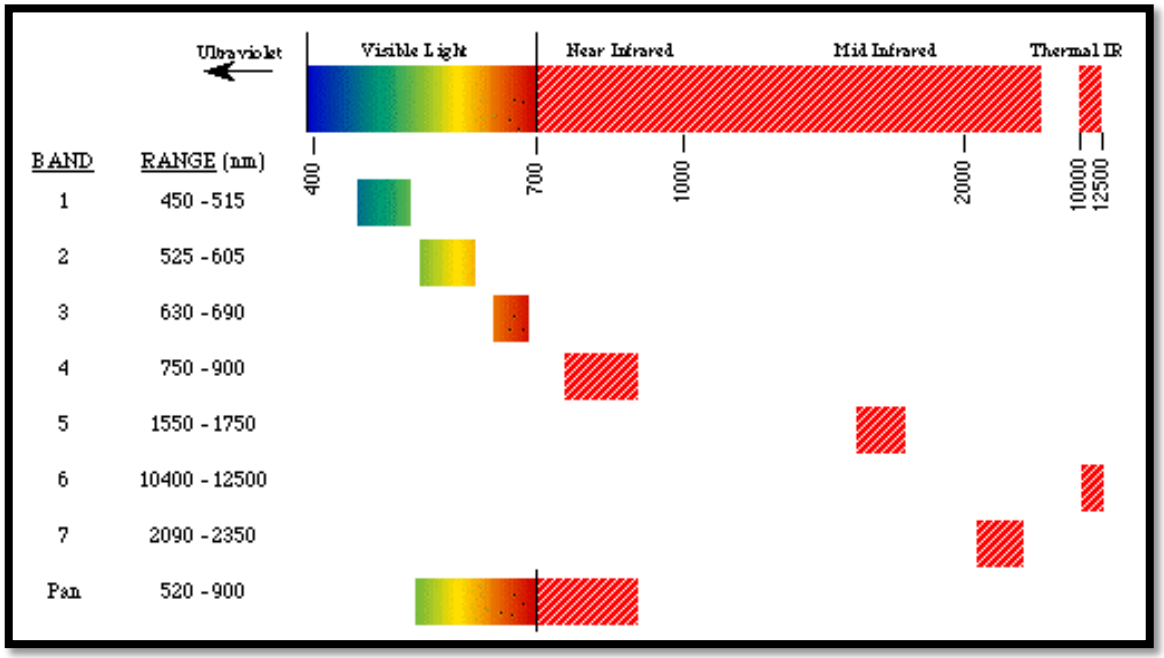
1970 1980 1990 2000 2010

Commercial operations

Government operations

Characteristics of Landsat: Spectral

- Landsat instruments measure primarily light that is reflected from Earth's surface (with one exception)
- Landsat instruments are designed to detect visible and infrared (near and mid) wavelengths.



Landsat bands of ETM+ (Landsat 7)

Source: NASA Goddard Space Flight Center

Characteristics of Landsat 4, 5 and 7

Bands	Wavelength (micrometers)	Resolution (m) Landsat 4-5 (TM)	Resolution (m) Landsat 7 (ETM+)
Band 1-Blue	0.45-0.52	30	30
Band 2 Green	0.52-0.60	30	30
Band 3- Red	0.63-0.69	30	30
Band 4-Near Infrared	0.76-0.90	30	30
Band 5- Shortwave Infrared 1	1.55-1.75	30	30
Band 6- Thermal Infrared	10.40-12.50	120	60
Band 7- Shortwave Infrared 2	2.08-2.35	30	30
Band 8-Pan	0.52-0.90	--	15

Characteristics of Landsat 8

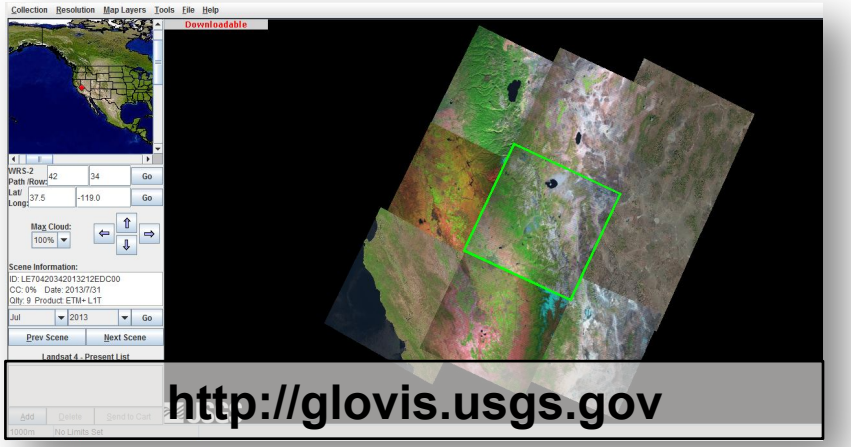
Bands	Wavelength (micrometers)	Spatial Resolution (meters)
Band 1-Coastal aerosol	0.43-0.45	30
Band 2- Blue	0.45-0.51	30
Band 3- Green	0.53-0.59	30
Band 4- Red	0.64-0.67	30
Band 5- Near Infrared	0.85-0.88	30
Band 6- SWIR 1	1.57-1.65	30
Band 7- SWIR 2	2.11-2.29	30
Band 8-Panchromatic	0.50-0.68	15
Band 9-Cirrus	1.36-1.38	30
Band 10- Thermal Infrared 1	10.60-11.19	100
Band 11- Thermal Infrared 2	11.50-12.51	100

Where to Obtain Landsat Images

The LandsatLook Viewer

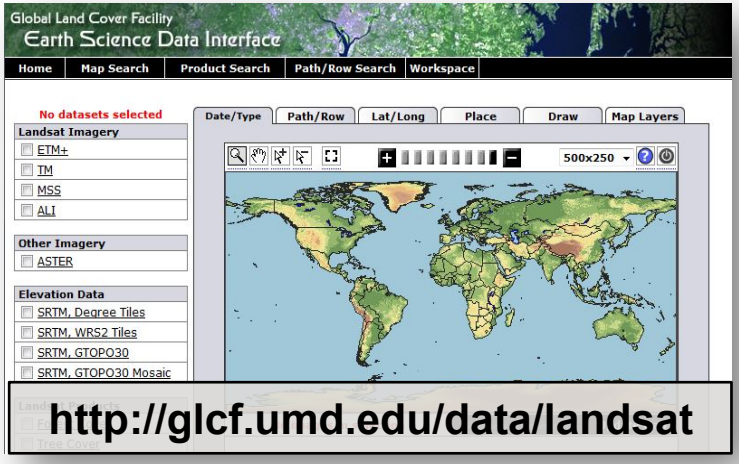
http://landsatlook.usgs.gov

GloVis



http://glovis.usgs.gov

Global Land Cover Facility



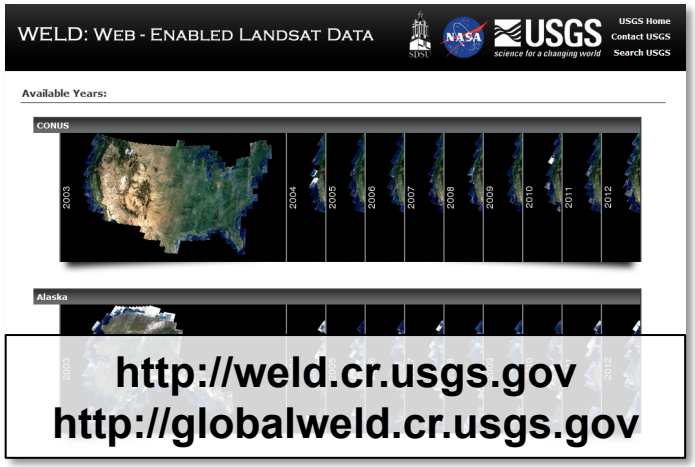
http://glcf.umd.edu/data/landsat

Earth Explorer

http://earthexplorer.usgs.gov

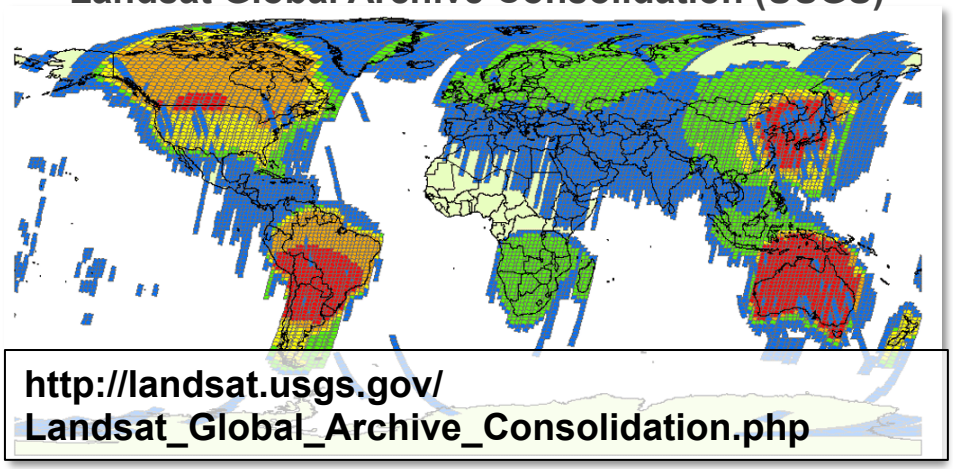
Where to Obtain Landsat Images and Products

WELD

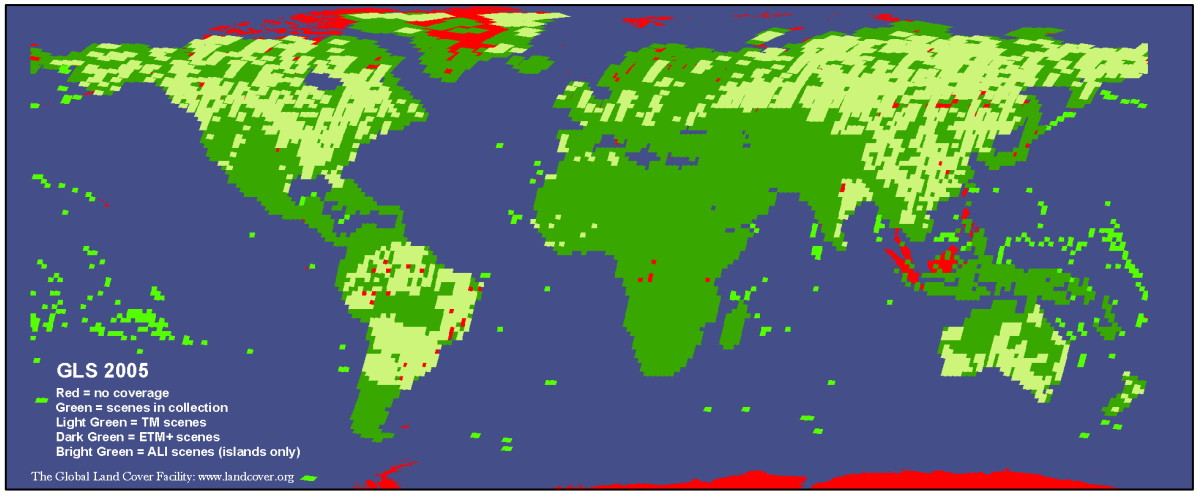


http://weld.cr.usgs.gov
http://globalweld.cr.usgs.gov

Landsat Global Archive Consolidation (USGS)

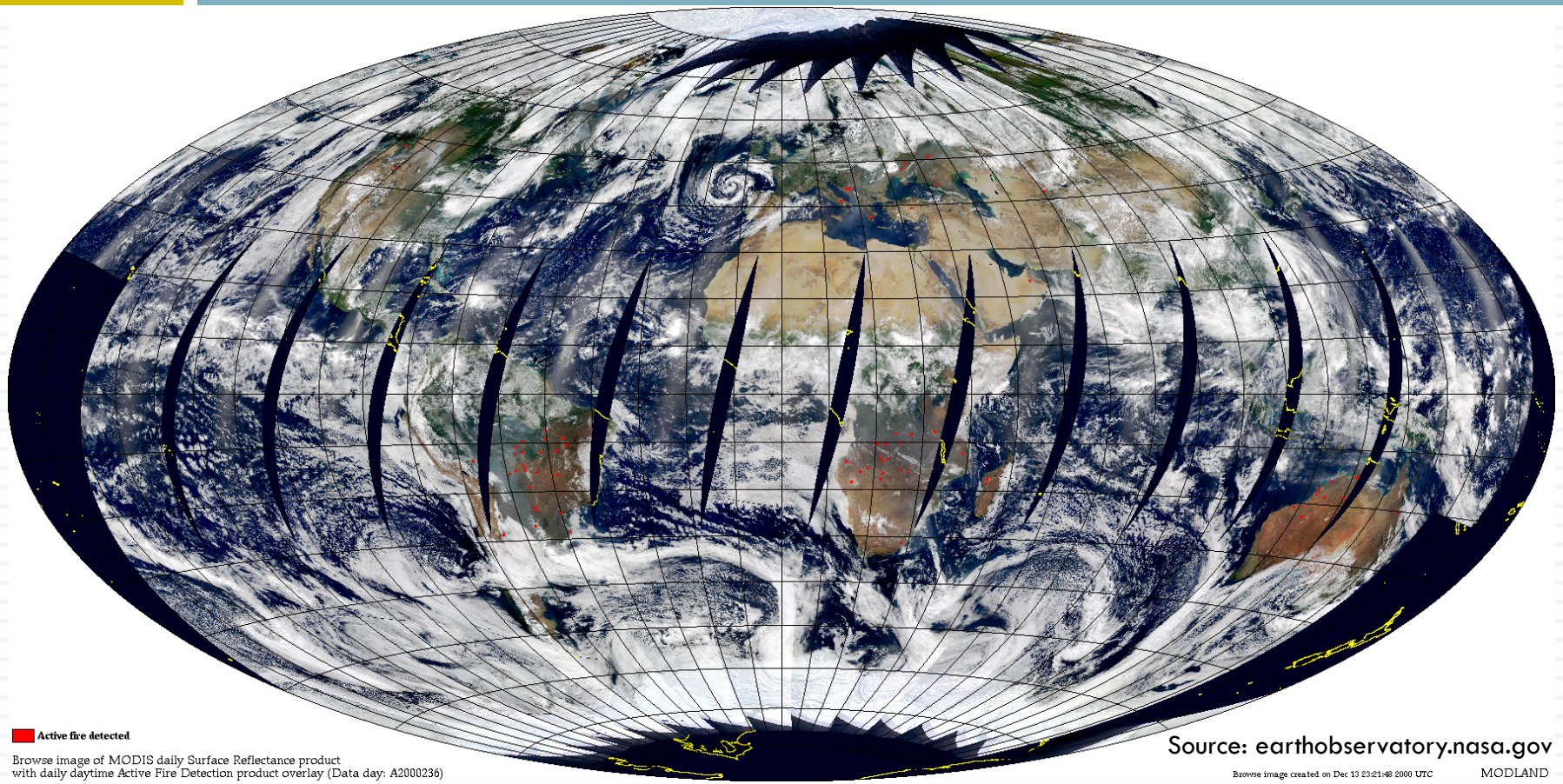


http://landsat.usgs.gov/Landsat_Global_Archive_Consolidation.php



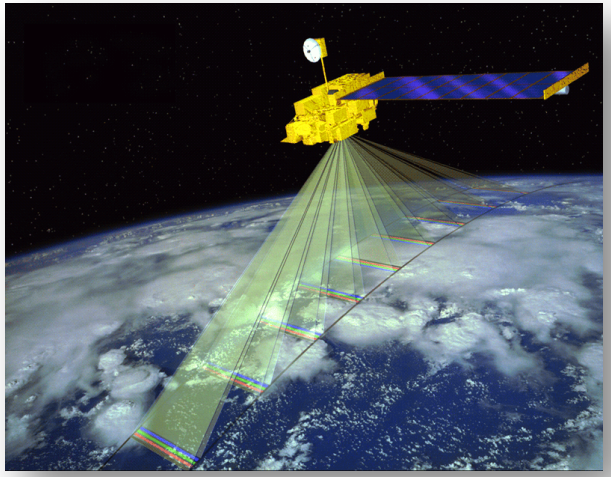
- Global Land Survey
- Not a data portal, but a global collection of cloud free Landsat images from 1975-2008.
- Time series include (GLS 1975, GLS 1990, GLS 2000, GLS 2005, GLS 2010)
- **Acquire GLS datasets through Earth Explorer, GloVis, and GLCF**

MODIS

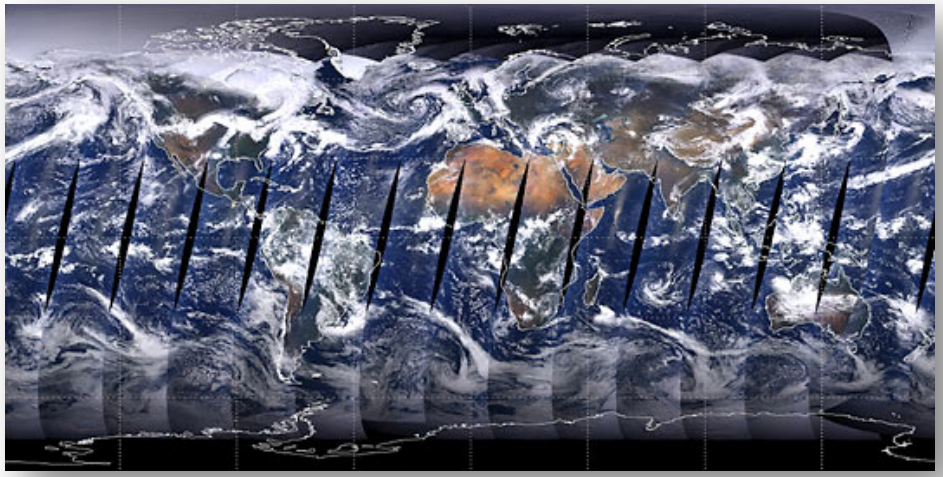


Source: earthobservatory.nasa.gov

MODIS (Moderate Resolution Imaging Spectroradiometer)



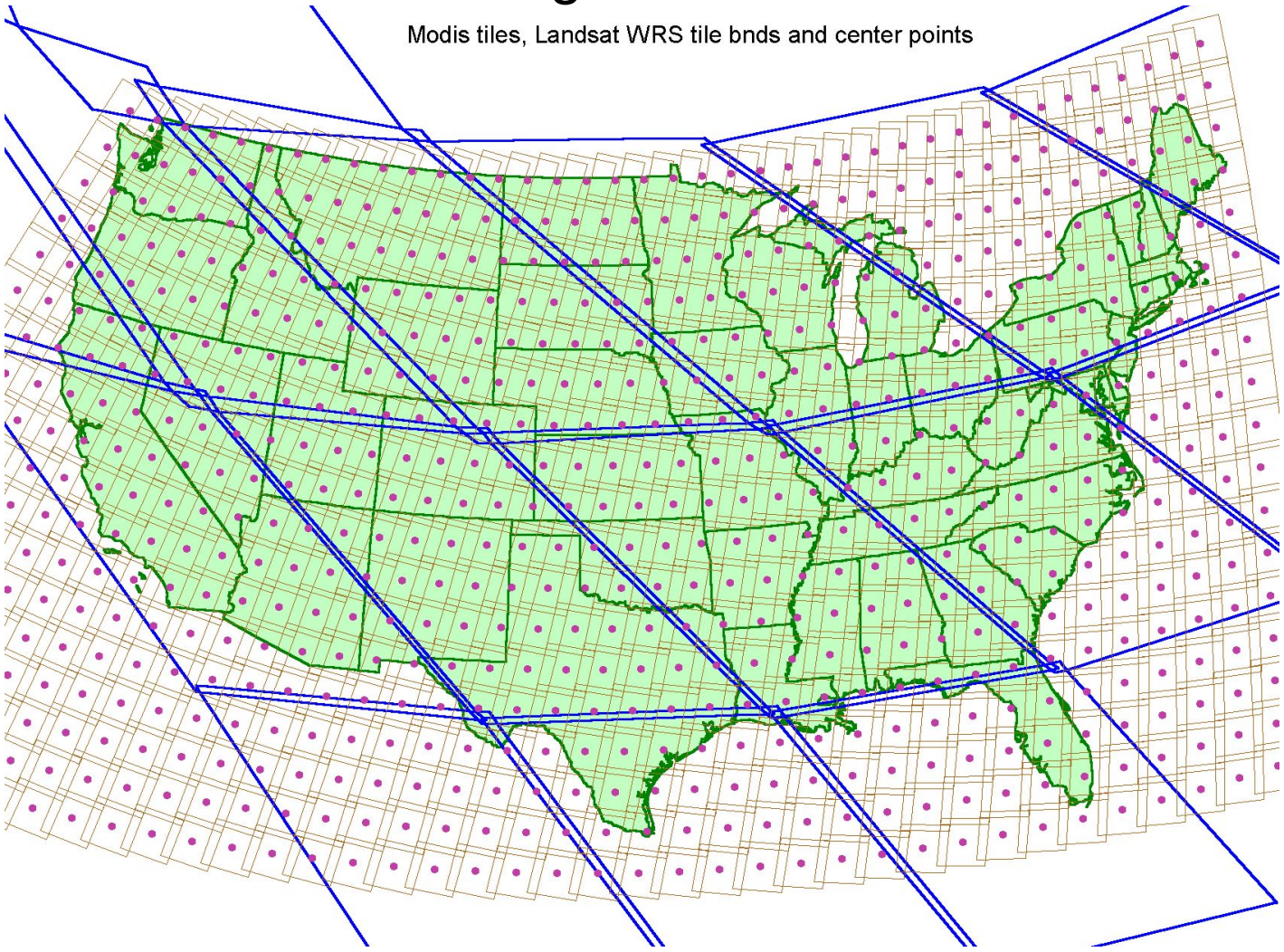
- Spatial Resolution
  - 250m, 500m, 1km
- Temporal Resolution
  - Daily, 8-day, 16-day, monthly, quarterly, yearly
  - 2000-present
- Data Format
  - Hierarchal data format – Earth Observing System Format (HDF-EOS)



- Spectral Coverage
  - 36 bands (major bands include Red, Blue, IR, NIR, MIR)
    - Bands 1-2: 250m
    - Bands 3-7: 500m
    - Bands 8-36: 1000m

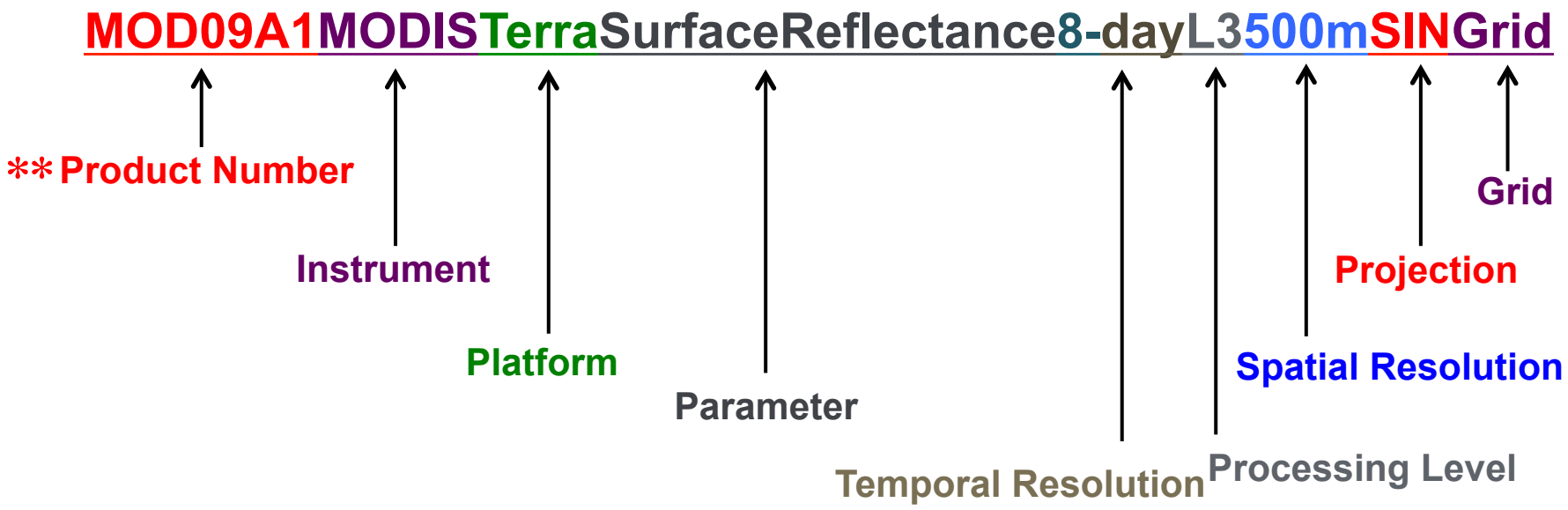
MODIS Tiles vs. Landsat Images

Large swaths!



MODIS Naming Convention

MODIS filenames follow a naming convention which gives useful information regarding the specific product. For Example:



**NOTE: MOD – Terra; MYD – Aqua; MCD - Combined

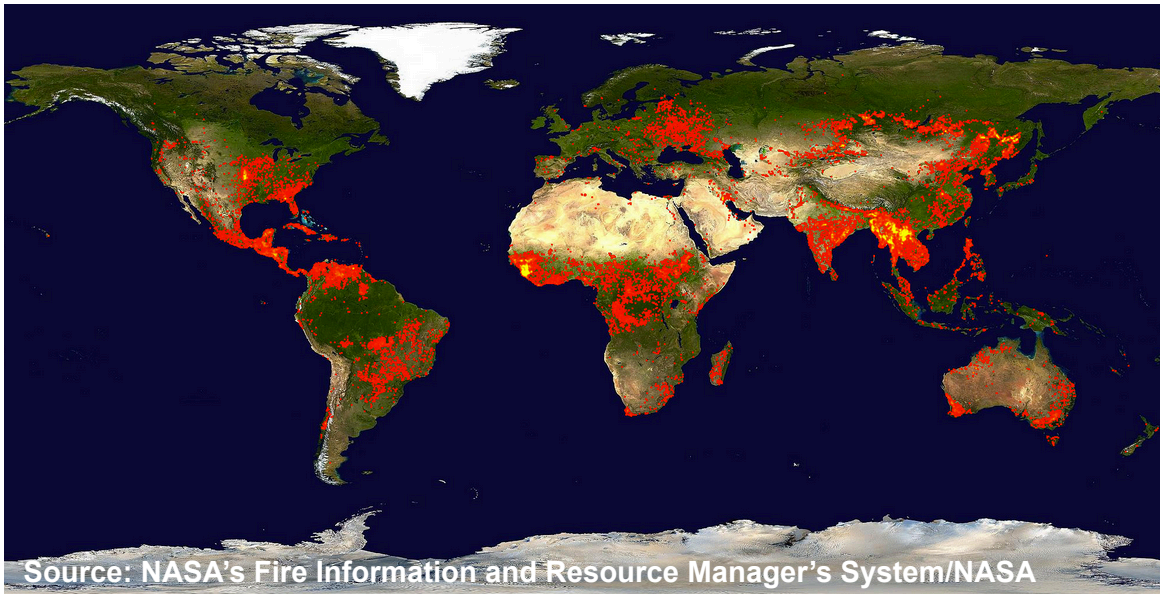
MODIS Land Products

MODIS Name	Product Name Short name	Spatial Resolution (m)	Temporal
MOD 09	Surface Reflectance	500	8-day
MOD 11	Land Surface Temperature	1000	Daily, 8-day
MOD 12	Land Cover/Change	500	8-day, Yearly
MOD 13	Vegetation Indices	250-1000	16 day, monthly
MOD 14	Thermal Anomalies/Fire	1000	Daily, 8-day
MOD 15	Leaf Area Index/Fraction of Absorbed Photosynthetically Active Radiation (FPAR)	1000	4-day, 8-day
MOD 16	Evapotranspiration		
MOD 17	Primary Production	1000	8-day, yearly
MOD 43	Bidirectional reflectance distribution function (BRDF)/Albedo	500-1000	16-day
MOD 44	Vegetation Continuous Fields	250	yearly
MOD 45	Burned Area	500	monthly

- **All MODIS Land Products are available at processing Level 3**

MODIS Land Products: Thermal Anomalies (MYD14A1)

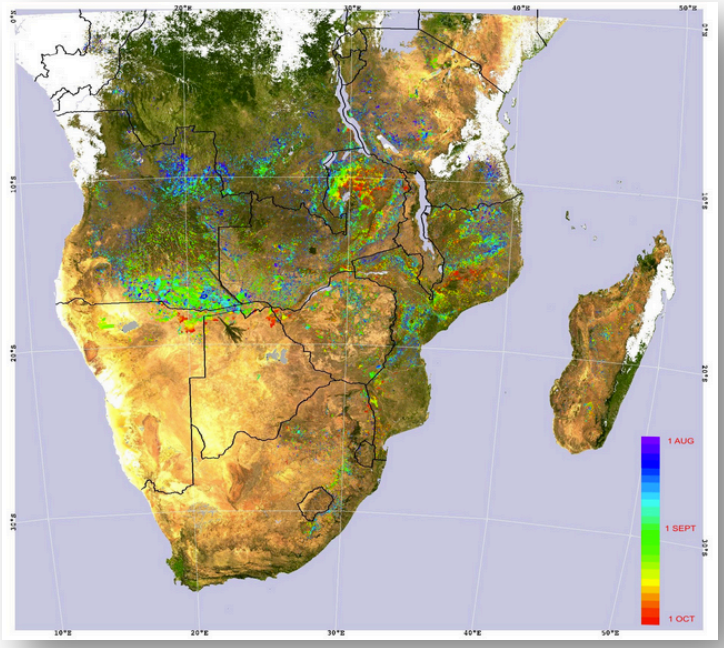
- Provides snapshots of active burning fires and burned areas
- The Active Fire product delivers actively burning locations on a daily basis at 1km resolution (additional 8 day and monthly products)
- Fire product includes multiple attributes such as fire mask, fire pixel table, and maximum fire radiative power
- The Thermal Anomalies product detects other thermal anomalies such as volcanic signatures



Global Fire Map (April 1-10, 2014)

MODIS Land Products: Burned Area (MCD45A1)

- The combined Terra & Aqua MODIS Burned Area Product is a monthly gridded 500m product
- MODIS detects the approximate date of burning at 500m resolution
- For more information: http://modis-fire.umd.edu

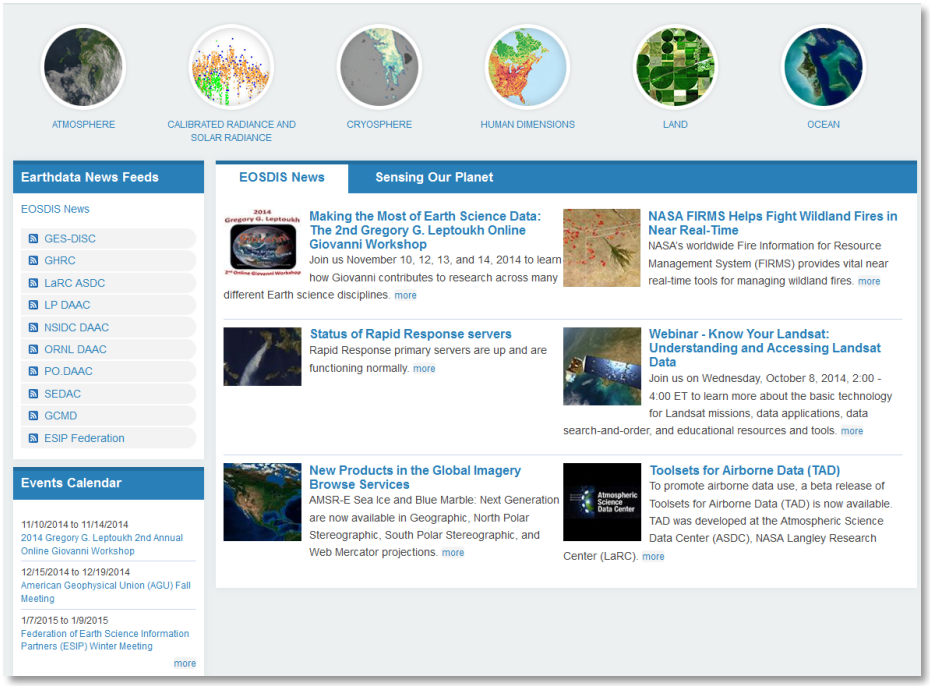


Example of the MODIS 500 m burned area product for sub equatorial Africa. The different colors indicate the approximate day of the burning detected between August and October in 2000.

Image courtesy of MODIS Fire Team

Where to Obtain Information on MODIS (and other) NASA Products

- Land Processes Distributed Active Archive (LP DAAC)
  - https://lpdaac.usgs.gov/products/modis_products_table
- Earth Observing System Data and Information System (EOSDIS):
  - http://Earthdata.nasa.gov



Where to Obtain MODIS Products

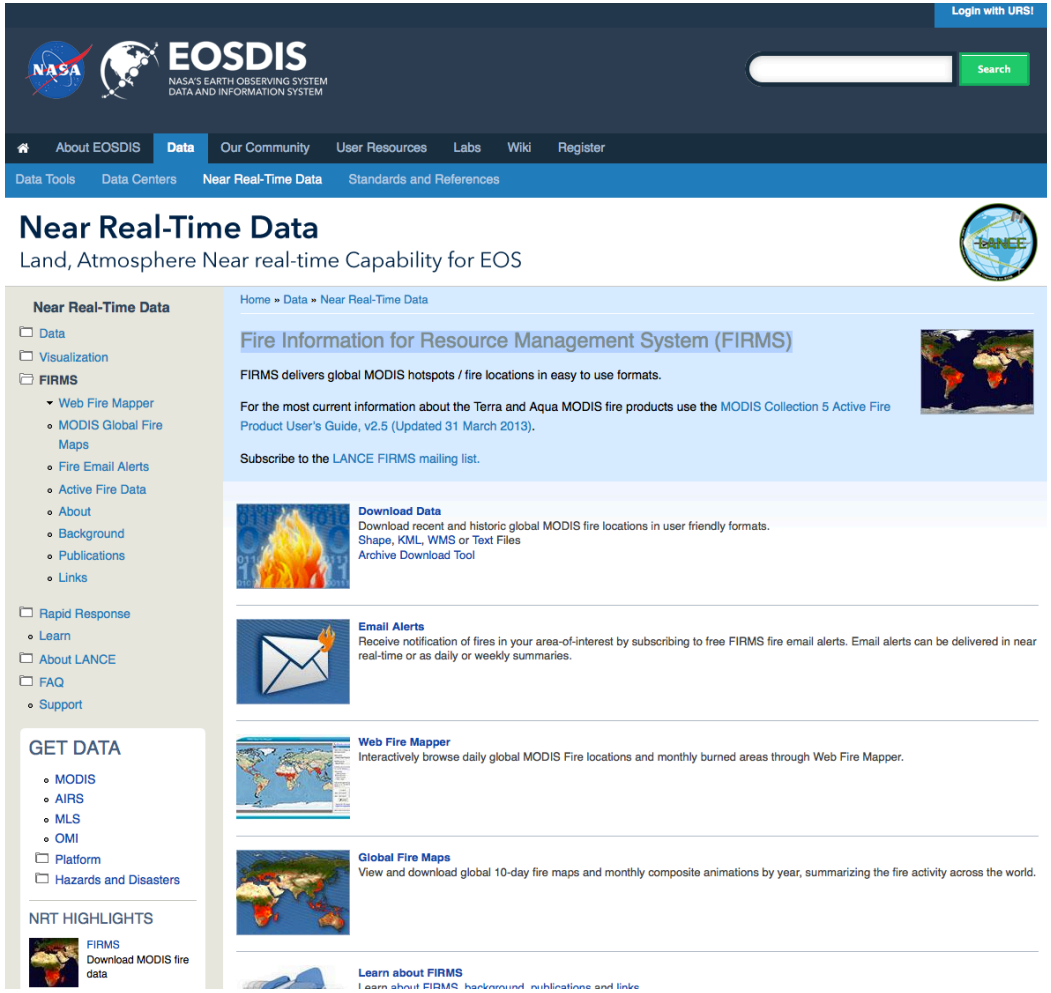
- ECHO Reverb
  - http://reverb.echo.nasa.gov
- Data Subsetting and Visualization: Oakridge National Lab DAAC (ORNL DAAC)
  - http://daac.ornl.gov
- GLCF
  - http://www.landcover.org/data/lc
- GLOVIS
  - http://glovis.usgs.gov
- Fire Information for Resource Management System (FIRMS)
  - https://earthdata.nasa.gov/data/near-real-time-data/firms

Where to Obtain MODIS Products

- Worldview (Fires, Land Surface Temperature and Snow Cover)
  - https://earthdata.nasa.gov/labs/worldview/
- Visualization: SERVIR
  - https://www.servirglobal.net/Global/MapsData/InteractiveMapper.aspx
- MRTWeb
  - http://mrtweb.cr.usgs.gov

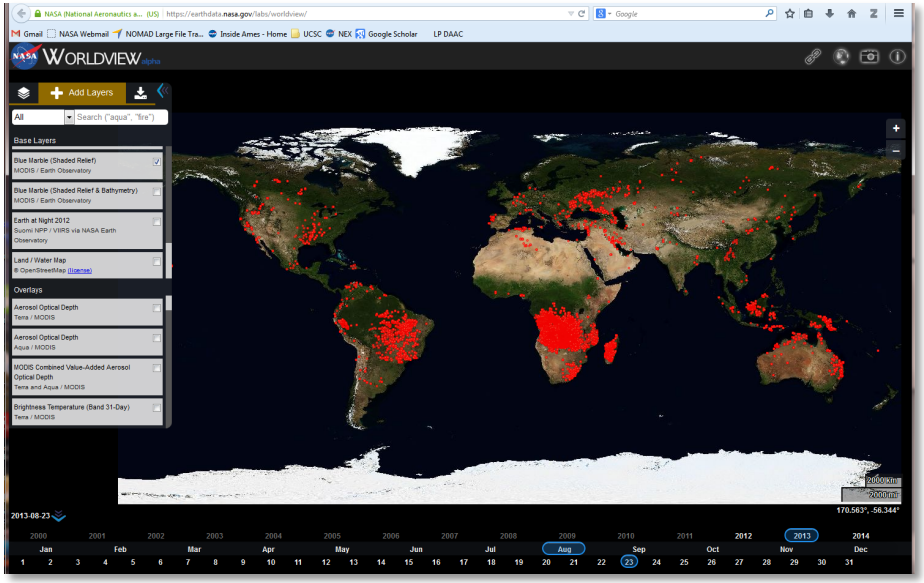
Fire Information for Resource Management System (FIRMS)

- Provides data for near real-time active fire locations using MODIS Fire Thermal Anomalies product.
- Provides historical data (older than 7 days) using the Archive Download Tool
- Obtain monthly MODIS Burned Area images from Web Fire Mapper
- Live demo at end of webinar

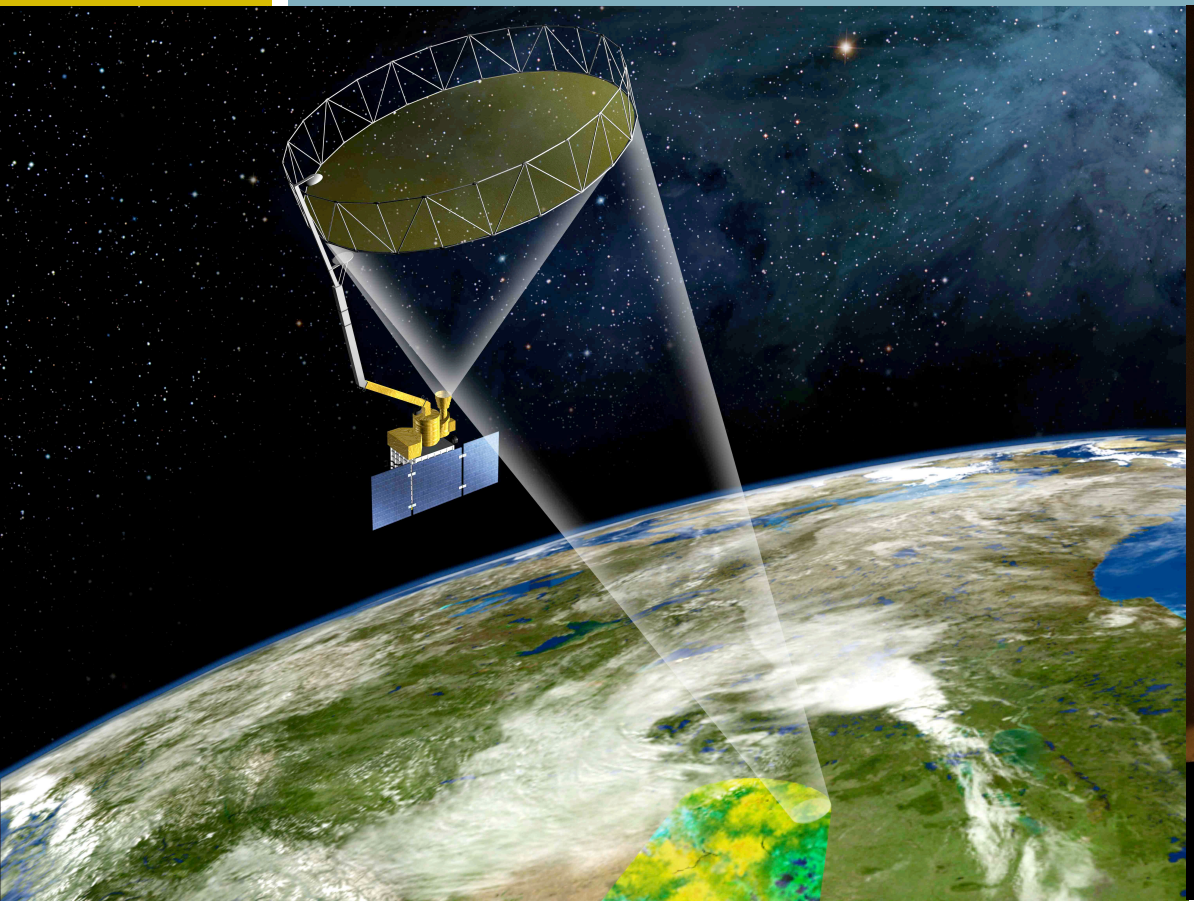


Worldview: Overview

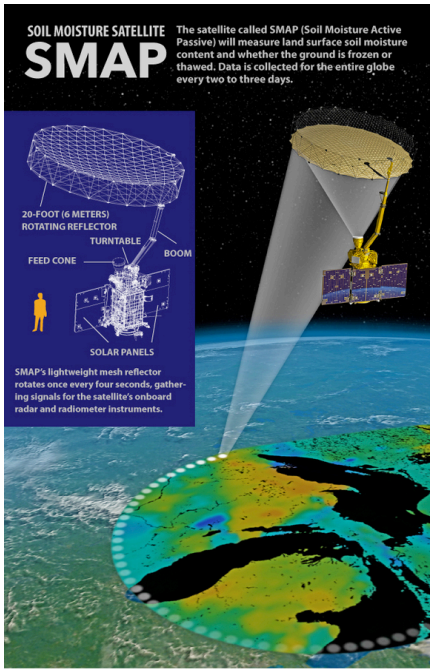
- Online tool for browsing and downloading over 100 satellite-derived products
  - Products updated within three hours of observation
  - Contains base layers for viewing and overlays for data download
- Wide range of products available including:
  - Fires
    - (Day and Night)
  - Land Surface Temperature
    - (Day and Night)
  - Snow Cover
  - Ice Extent
  - Water Vapor
- Live demo at end of webinar



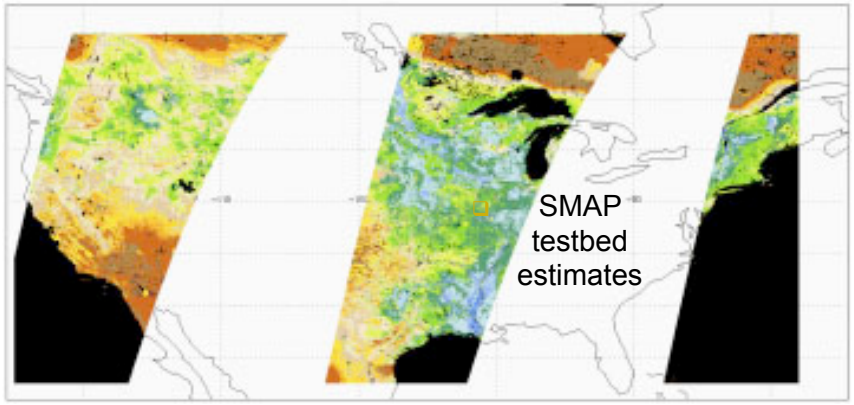
SMAP



Soil Moisture Active Passive (SMAP)



- Designed to measure soil moisture every 2-3 days in the top 5cm (2 inches)
- Launched on January 31st, 2015
- Spatial Resolution
  - 3km
- Temporal Resolution
  - Every 2-3 days
- Data Format
  - Hierarchal data format – Earth Observing System Format (HDF-EOS)

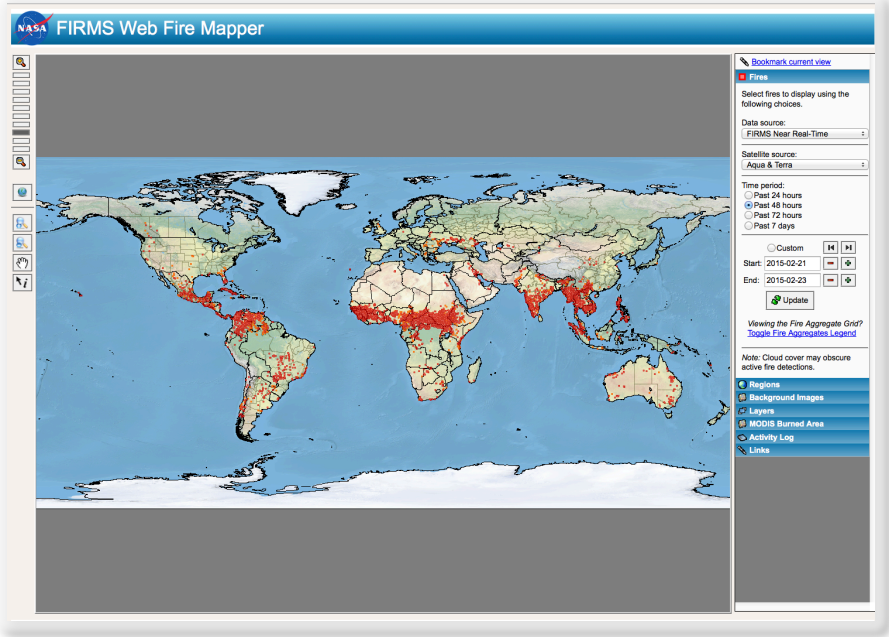


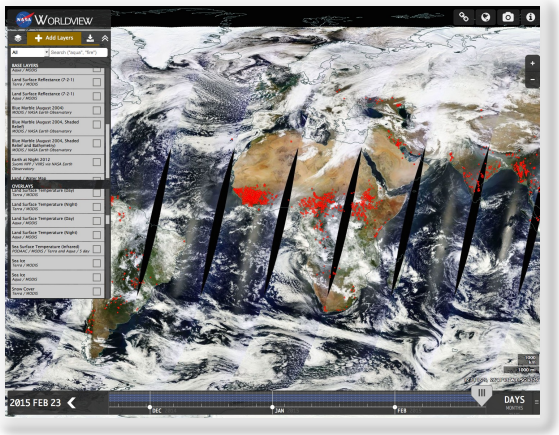
- Data will be available soon. For more information about data products and the product distribution portal visit: http://smap.jpl.nasa.gov/data/
- More SMAP info during week 4

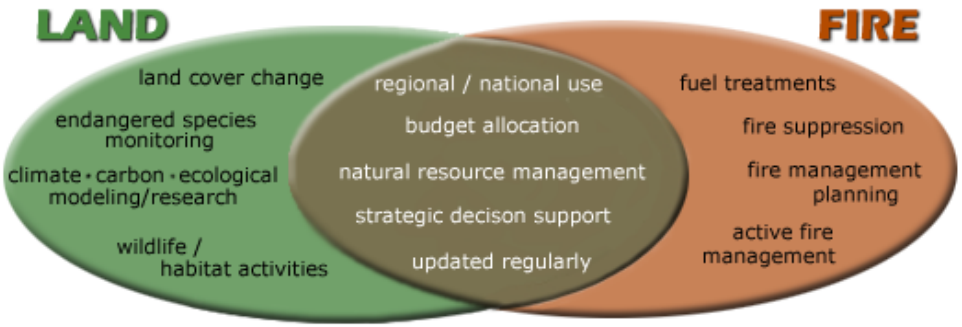
Wildfire Products and Tools

Wildfire Products and Tools

- LANDFIRE
- FRAMES
- FIRMS
  - Web Fire Mapper
  - Global Fire Maps
- Worldview



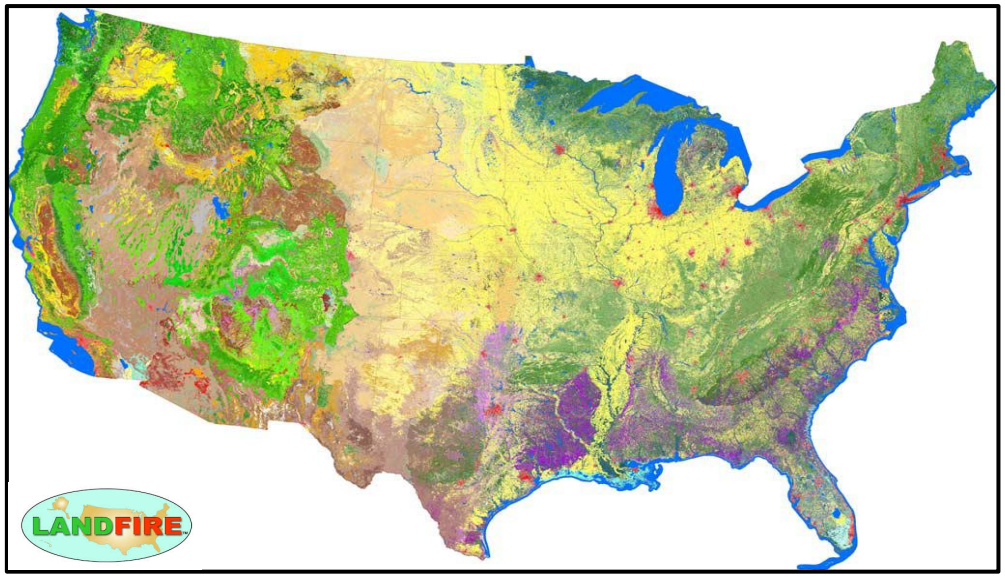




Landscape Fire and Resource Management Planning Tools (LANDFIRE)

- Joint program between wildland fire management programs of USDA Forest Service and US Department of Interior
- Provides consistent, comprehensive, geospatial data for vegetation, wildland fuel, and fire regimes in United States
  - Data and reports
  - Videos and tutorials
  - Decision-making tools

LANDFIRE Products



http://www.landfire.gov

Products: Delivered at 30 m spatial resolution

- **Vegetation data layers** using Landsat imagery from 1999 - present
  - Current and historic vegetation composition and structure of the entire U.S.
- **Fuel and Fire Regime data layers**
  - Fire behavior and fuel loading models for entire U.S. 1999 -present
- **Disturbance data**
  - Fuel, vegetation, natural, and prescribed disturbance by type and year 1999-present

LANDFIRE Data Access Tool

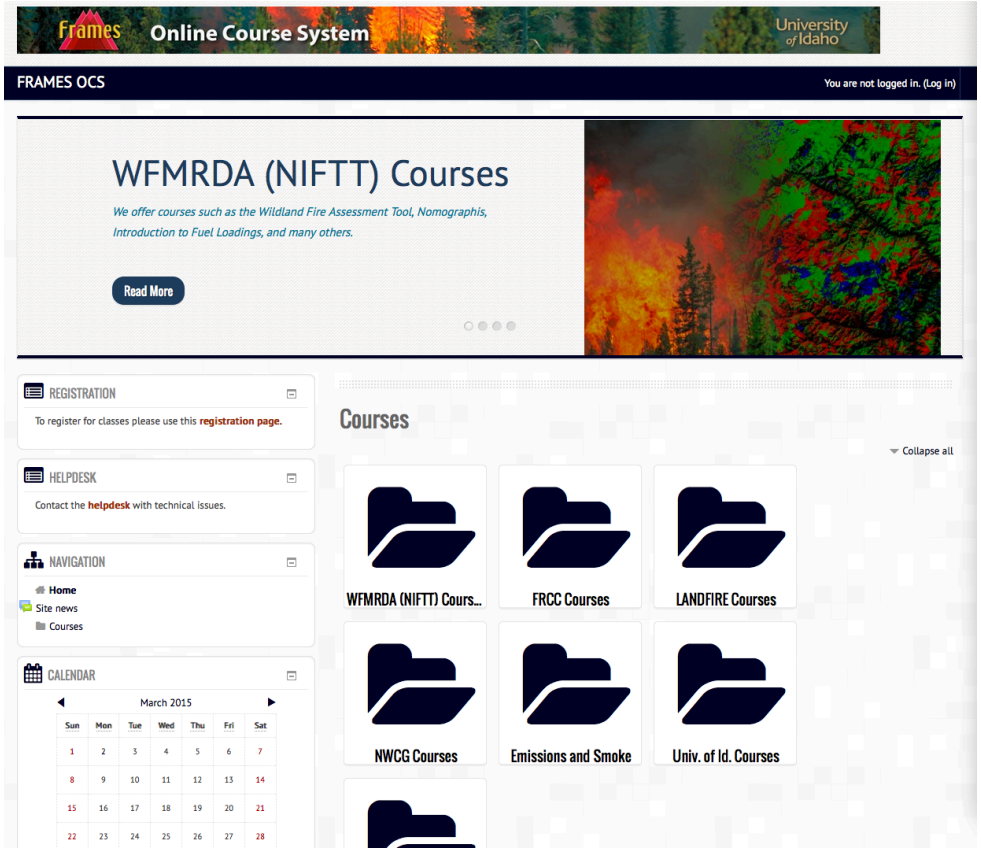
- ArcGIS toolbar developed by the Rocky Mountain Research Station and distributed by Wildland Fire Management RD&A Fuels and Fire Ecology Program
  - Interact with LANDFIRE data directly from ArcMap
    - Select data
    - Define data extent
    - Download raster
  - The tool also allows you to:
    - Reproject the raster
    - Build a FARSITE landscape
    - Disassemble a FARSITE landscape back to original input
    - Attach database file
  - http://www.landfire.gov/datatool.php

LFDAT	**10.2**	**LANDFIRE Data Access Tool 2.5** Downloads LANDFIRE data directly from ArcMap version 10.2 **Prior to contacting the help desk, please refer to the LFDAT User Guide or the LFDAT FAQs page.**	LFDAT 2.5 (zip) LFDAT Tutorial (zip) LFDAT User's Guide (pdf) LFDAT FAQs

Fire Research and Management Exchange System (FRAMES)

- Provides a method of exchanging information and transferring technology among wildland fire researcher, managers, and other stakeholders in an online environment

- Online Courses: https://www.frames.gov/onlinecourses/



Live Demos

Fire Information for Resource Management System (FIRMS):
https://earthdata.nasa.gov/data/near-real-time-data/firms

NASA Worldview:
https://earthdata.nasa.gov/labs/worldview/

Coming up next week!

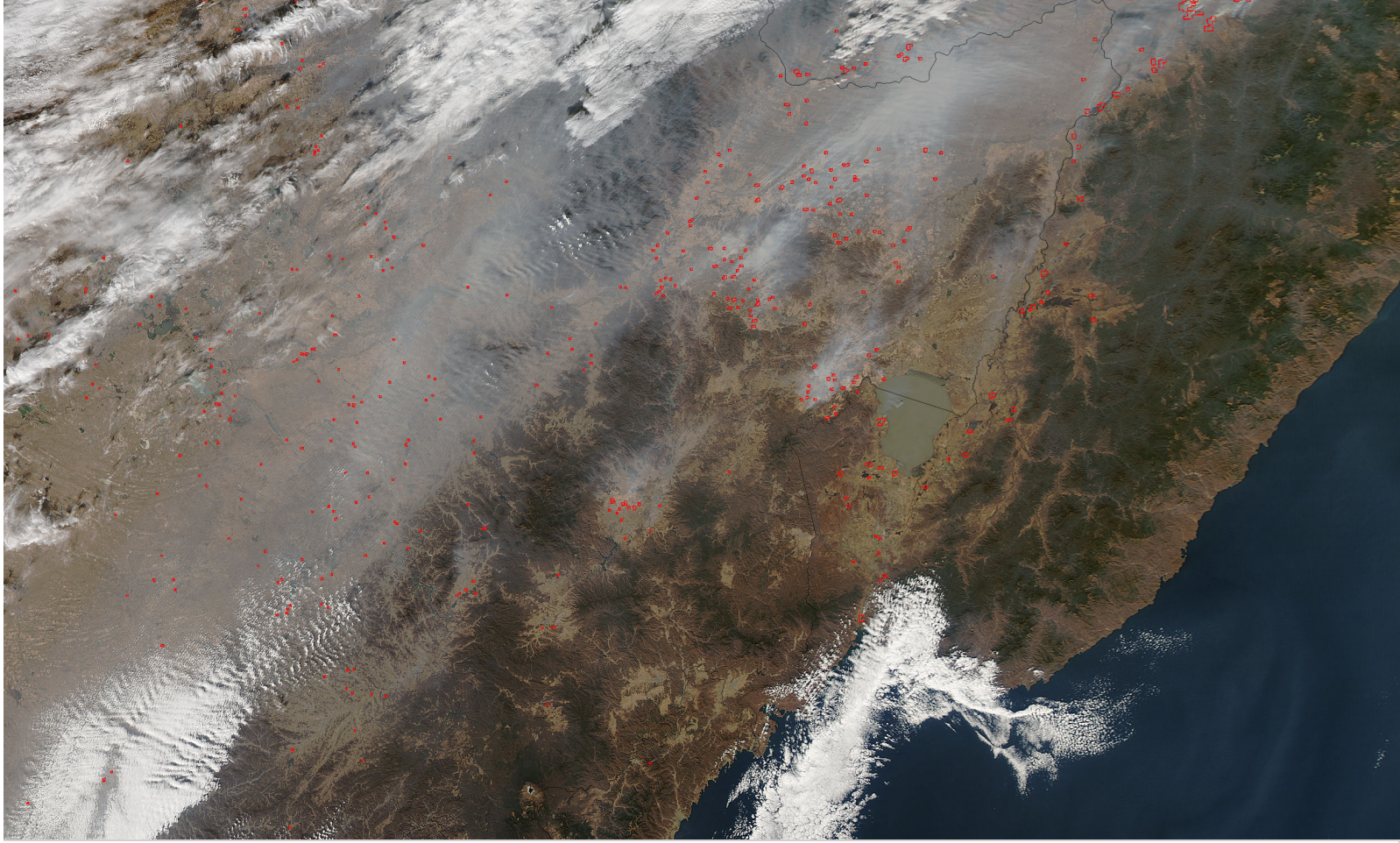
Week 3: Remote sensing products for pre- and post wildfire planning and assessment

Important Information

- One lecture per week – every Tuesday from March 31 to April 28 (11:30 AM – 12:30 PM EST)
- Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at: https://arset.gsfc.nasa.gov/disasters/webinars/introduction-remote-sensing-wildfire-applications
- Certificate of Completion
  - Attend 4 out of 5 webinars
  - Assignment 1 and 2 – access from the ARSET wildfire webinar website (above)
  - You will receive certificates approximately 1 month after the completion of the course from: marines.martins@ssaihq.com
- Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

MODIS image of small fires, smoke and haze in eastern China.

November 3, 2014



Thank You!!

Cindy Schmidt
Cynthia.L.Schmidt@nasa.gov